

414 Received 15 JAN 1999

FORM-PTO-1390
(Rev. 10-96)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

024444-580

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)

09/214923INTERNATIONAL APPLICATION NO.
PCT/SE97/01243INTERNATIONAL FILING DATE
July 8, 1997PRIORITY DATE CLAIMED
July 19, 1996TITLE OF INVENTION
CEMENTED CARBIDE INSERT FOR TURNING, MILLING AND DRILLINGAPPLICANT(S) FOR DO/EO/US
Mats WALDENSTRÖM, Åke ÖSTLUND and Ove ALM

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and the PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
International Search Report; Preliminary Examination Report; and PCT Demand

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.50)		INTERNATIONAL APPLICATION NO. PCT/SE97/01243		ATTORNEY'S DOCKET NUMBER 024444-580	
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17. <input checked="" type="checkbox"/> The following fees are submitted:	CALCULATIONS	PTO USE ONLY			
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$670.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$760.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00 <div style="text-align: right; margin-top: 10px;"> ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 970.00 </div>					
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).					
Claims	Number Filed	Number Extra	Rate		
Total Claims	2 -20 =	0	X\$18.00	\$ 0	
Independent Claims	1 -3 =	0	X\$78.00	\$ 0	
Multiple dependent claim(s) (if applicable)			+ \$260.00	\$ 0	
TOTAL OF ABOVE CALCULATIONS =				\$ 970.00	
Reduction for 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$ 0	
SUBTOTAL =				\$ 970.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0	
TOTAL NATIONAL FEE =				\$ 970.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 0	
TOTAL FEES ENCLOSED =				\$ 970.00	
				Amount to be: refunded	\$
				charged	\$

a. ☒ A check in the amount of \$ 970.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 02-4800 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4800. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Ronald L. Grudziecki
 BURNS, DOANE, SWECKER & MATHIS, L.L.P.
 P.O. Box 1404
 Alexandria, Virginia 22313-1404

SIGNATURE
 Ronald L. Grudziecki
 NAME
24,970
 REGISTRATION NUMBER

FORM-PTO-1390
(Rev. 10-96)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
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024444-580

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)

09/214,923

INTERNATIONAL APPLICATION NO.
PCT/SE97/01243INTERNATIONAL FILING DATE
July 8, 1997PRIORITY DATE CLAIMED
July 19, 1996

TITLE OF INVENTION

CEMENTED CARBIDE INSERT FOR TURNING, MILLING AND DRILLING

APPLICANT(S) FOR DO/EO/US

Mats WALDENSTRÖM, Åke ÖSTLUND and Ove ALM

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1. ☐ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☒ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
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☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

04/22/1999 PVDLPE 00000159 09214923

01 FC:154

130.00 00

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.50)
09/214,923

INTERNATIONAL APPLICATION NO.
PCT/SE97/01243

ATTORNEY'S DOCKET NUMBER
024444-580

17. ☒ The following fees are submitted:

CALCULATIONS

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No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$760.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$970.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$ 0

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

\$ 130.00

Claims	Number Filed	Number Extra	Rate		
Total Claims	2 -20 =	0	X\$18.00	\$ 0	
Independent Claims	1 -3 =	0	X\$78.00	\$ 0	
Multiple dependent claim(s) (if applicable)			+\$260.00	\$ 0	

TOTAL OF ABOVE CALCULATIONS =

\$ 130.00

Reduction for 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).

\$ 0

SUBTOTAL =

\$ 130.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

\$ 0

TOTAL NATIONAL FEE =

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\$ 0

TOTAL FEES ENCLOSED =

\$ 130.00

Amount to be:
refunded \$

charged \$

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SEND ALL CORRESPONDENCE TO:

Ronald L. Grudziecki
BURNS, DOANE, SWECKER & MATHIS, L.L.P.
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Alexandria, Virginia 22313-1404

SIGNATURE

Ronald L. Grudziecki
NAME

24,970
REGISTRATION NUMBER

09/214925

300 Rec'd PCT/PTO 15 JAN 1999

Patent
Attorney's Docket No. 024444-580

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of)
)
Åke ÖSTLUND et al.) Group Art Unit: Unassigned
)
Application No.: Unassigned) Examiner: Unassigned
)
Filed: January 15, 1999)
)
For: CEMENTED CARBIDE INSERT)
FOR TURNING, MILLING AND)
DRILLING)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, after the title and before the first paragraph, please add the heading

--BACKGROUND OF THE INVENTION--;

line 20, after "time", please insert --,--;

line 22, after "milling", please insert --,--; and

line 32, after "in", please insert --,--; and after "e.g.", please insert --,--.

Page 2, line 4, after "drilling", please insert --,--;

line 14, after "cast)", please insert --,--; and

line 17, after "steels", please insert --,--.

Page 3, line 4, before the paragraph beginning with "It has now surprisingly...",
please add the following heading and paragraph:

--OBJECTS AND SUMMARY OF THE INVENTION

It is an aspect of this invention to provide a method of making a cemented carbide insert provided with a thin wear resistant coating with excellent properties for machining of steels and stainless steels comprising WC, 5-12.5 wt-% Co and 0-10 wt-% cubic carbides such as TiC, TaC, NbC or mixtures thereof wherein the WC-grains have an average grain size in the range of 1.0-3.0 μm , the WC grains have a narrow grain size distribution in the range 0.5-4.5 μm , the W-content in the binder phase expressed as the "CW-ratio" defined as $\text{CW-ratio} = M_s / \text{wt\%Co} * 0.0161$ where M_s is the measured saturation magnetization of the sintered cemented carbide insert in kA/m and wt% Co is the weight percentage of Co in the cemented carbide, is 0.86-0.96.--;

after line 11, before the paragraph beginning with "Fig. 1 shows in...",
please add the following heading

--BRIEF DESCRIPTION OF THE DRAWINGS--;

after line 15, before the paragraph beginning with "According to the invention...", please add the following heading

--DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION--;

line 16, after "invention", please insert --,--; and

line 30, after "embodiment", please insert --,--.

Page 4, line 21, after "embodiment", please insert --,--;

line 24, after "invention", please insert --,--; and

line 35, after "milling", please insert --,--; and after "i.e.", please insert

--,--.

Page 5, line 11, after "embodiment", please insert --,--;

line 15, after "case", please insert --,--; and

after the paragraph ending at line 22, please insert the following new

paragraph:

--The invention is additionally illustrated in connection with the following Examples which are to be considered as illustrative of the present invention. It should be understood, however, that the invention is not limited to the specific details of the Examples.--.

Page 6, line 9, after "coating", please insert --,--.

Page 15, after the last paragraph ending at line 10, please insert the following new paragraph:

--The principles, preferred embodiments and modes of operation of the present invention have been described in the foregoing specification. The invention which is intended to be protected herein, however, is not to be construed as limited to the particular forms disclosed, since these are to be regarded as illustrative rather than restrictive. Variations and changes may be made by those skilled in the art without departing from the spirit of the invention.--.

Page 16, please delete "Claims" and insert therefor --WHAT IS CLAIMED IS--.

IN THE CLAIMS

Please amend claims 1 and 2 as follows:

1. (Amended) A cemented carbide insert provided with a thin wear resistant coating with excellent properties for machining of steels and stainless steels comprising [consisting of] WC, 5-12.5 wt-% Co and 0-10 wt-% cubic carbides such as TiC, TaC, NbC or mixtures thereof wherein [in which] the WC-grains have an average grain size in the range 1.0-3.0 μm , [characterised in that] the WC grains have a narrow grain size distribution in the range 0.5-4.5 μm , [and] the W-content in the binder phase expressed as the "CW-ratio" defined as

$$\text{CW-ratio} = M_s / \text{wt\% Co} * 0.0161$$

where M_s is the measured saturation magnetization of the sintered cemented carbide insert in kA/m and wt% Co is the weight percentage of Co in the cemented carbide, is 0.86-0.96.

2. (Amended) The [A] cemented carbide insert of [according to the preceding] claim 1 wherein [characterised in that] said coating comprises $\text{TiC}_x\text{N}_y\text{O}_z$ with columnar grains followed by a layer of $\alpha\text{-Al}_2\text{O}_3$, $\kappa\text{-Al}_2\text{O}_3$ or a mixture of α - and $\kappa\text{-Al}_2\text{O}_3$.

Page 17, line 1, please delete "Abstract" and insert therefor --ABSTRACT OF THE DISCLOSURE--;

line 2, please delete "The present invention relates to" and insert therefor --There is disclosed--; and

line 12, please delete "i".

Application No. Unassigned
Attorney's Docket No. 024444-580

REMARKS

The amendments to the above-identified application are clerical in nature and have been made to place the application in the accepted U.S. format. The new claims have been added to more clearly reflect Applicant's invention and an Abstract of the Disclosure has been included. No new matter has been added.

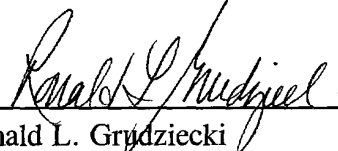
Early examination and allowance of the claims is earnestly solicited.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Post Office Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

By: _____


Ronald L. Grydziecki
Registration No. 24,970

Date: January 15, 1999

Cemented carbide insert for turning, milling and
drilling

The present invention relates to a cemented carbide
5 cutting tool insert, particularly useful for turning,
milling and drilling of steels and stainless steels.

Conventional cemented carbide inserts are produced
by powder metallurgical methods including milling of a
powder mixture forming the hard constituents and the
10 binder phase, pressing and sintering. The milling operation is an intensive milling in mills of different sizes and with the aid of milling bodies. The milling time is of the order of several hours up to several days. Such processing is believed to be necessary in
15 order to obtain a uniform distribution of the binder phase in the milled mixture. It is further believed that the intensive milling creates a reactivity of the mixture which further promotes the formation of a dense structure. However, milling has its disadvantages.
20 During the long milling time the milling bodies are worn and contaminate the milled mixture. Furthermore even after an extended milling a random rather than an ideal homogeneous mixture may be obtained. Thus, the properties of the sintered cemented carbide containing two or
25 more components depend on how the starting materials are mixed.

There exist alternative technologies to intensive milling for production of cemented carbide, for example, use of particles coated with binder phase metal. The
30 coating methods include fluidized bed methods, solgel techniques, electrolytic coating, PVD coating or other methods such as disclosed in e. g. GB 346,473, US 5,529,804 or US 5,505,902. Coated carbide particles could be mixed with additional amounts of cobalt and
35 other carbide powders to obtain the desired final

material composition, pressed and sintered to a dense structure.

During metal cutting operations like turning, milling and drilling the general properties such as hardness, resistance against plastic deformation, resistance against formation of thermal fatigue cracks are to a great extent related to the volume fraction of the hard phases and the binder phase in the sintered cemented carbide body. It is well known that increasing the amount of the binder phase reduces the resistance to plastic deformation. Different cutting conditions require different properties of the cutting insert. When cutting of steels with raw surface zones (e.g. rolled, forged or cast) a coated cemented carbide insert must consist of tough cemented carbide and have a very good coating adhesion as well. When turning, milling or drilling in low alloyed steels or stainless steels the adhesive wear is generally the dominating wear type.

Measures can be taken to improve the cutting performance with respect to a specific wear type. However, very often such action will have a negative effect on other wear properties.

The influence of some possible measures is given below:

1. Milling, turning or drilling at high cutting speeds and high cutting edge temperature require a cemented carbide with a rather large amount of cubic carbides (a solid solution of WC-TiC-TaC-NbC). Thermal fatigue cracks will often more easily develop in such carbides.

2. The formation of thermal fatigue cracks can be reduced by lowering the binder phase content. However, such action will lower the toughness properties of the cutting insert which is not desirable.

3. Improved abrasive wear can be obtained by increasing the coating thickness. However, thick coatings increase the risk for flaking and will lower the resistance to adhesive wear.

5 It has now surprisingly been found that cemented carbide inserts made from powder mixtures with hard constituents with narrow grain size distributions and without conventional milling have excellent cutting performance in steels and stainless steels with or
10 without raw surfaces in turning, milling and drilling under both dry and wet conditions.

Fig. 1 shows in 1200X the microstructure of a cemented carbide insert according to the invention.

15 Fig. 2 shows in 1200X the microstructure of a corresponding insert made according to prior art.

According to the invention there is now provided cemented carbide inserts with excellent properties for machining of steels and stainless steels comprising WC and 4 - 20 wt-% Co, preferably 5 - 12.5 wt-% Co and 0 -
20 30 wt-% cubic carbide, preferably 0 - 15 wt-% cubic carbide, most preferably 0 - 10 wt-% cubic carbide such as TiC, TaC, NbC or mixtures thereof. The WC-grains have an average grain size in the range 0.8 - 3.5 μm , preferably 1.0 - 3.0 μm . The microstructure of the cemented
25 carbide according to the invention is further characterized by a narrow grain size distribution of WC in the range 0.5 - 4.5 μm , and a lower tendency for the cubic carbide particles, when present, to form long range skeleton, compared to conventional cemented carbide.

30 In another alternative embodiment there is provided cemented carbide inserts comprising WC and 10 - 25 wt-% Co, preferably 15 - 20 wt-% Co, and <2 wt-%, preferably <1 wt-% cubic carbides such as Cr_3C_2 and/or VC added as grain growth inhibitors. The WC-grains have an average
35 grain size 0.2 - 1.0 μm . The microstructure of cemented

carbide according to the invention is further characterized by a narrow grain size distribution of WC in the range 0 - 1.5 μm .

- The amount of W dissolved in binder phase is
 5 controlled by adjustment of the carbon content by small additions of carbon black or pure tungsten powder. The W-content in the binder phase can be expressed as the "CW-ratio" defined as

$$\text{CW-ratio} = M_S / (\text{wt\%Co} * 0.0161)$$

- 10 where M_S is the measured saturation magnetization of the sintered cemented carbide body in kA/m and wt% Co is the weight percentage of Co in the cemented carbide. The CW-ratio in inserts according to the invention shall be 0.82 - 1.0, preferably 0.86 - 0.96.

- 15 The sintered inserts according to the invention are used coated or uncoated, preferably coated with MTCVD, conventional CVD or PVD with or without Al_2O_3 . In particular, multilayer coatings comprising $\text{TiC}_x\text{N}_y\text{O}_z$ with columnar grains followed by a layer of $\alpha\text{-Al}_2\text{O}_3$, $\kappa\text{-Al}_2\text{O}_3$
 20 or a mixture of α - and $\kappa\text{-Al}_2\text{O}_3$, have shown good results. In another preferred embodiment the coating described above is completed with a TiN-layer which could be brushed or used without brushing.

- According to the method of the present invention WC-
 25 powder with a narrow grain size distribution is wet mixed without milling with deagglomerated powder of other carbides generally TiC, TaC and/or NbC, binder metal and pressing agent, dried preferably by spray drying, pressed to inserts and sintered.

- 30 WC-powder with a narrow grain size distributions according to the invention with eliminated coarse grain tails $>4.5 \mu\text{m}$ and with eliminated fine grain tails, $<0.5 \mu\text{m}$, are prepared by sieving such as in a jetmill-classifier. It is essential according to the invention
 35 that the mixing takes place without milling i.e. there

should be no change in grain size or grain size distribution as a result of the mixing.

Hard constituents with narrow grain size distributions according to the alternative embodiment with
 5 eliminated coarse grain tails $>1.5 \mu\text{m}$ are prepared by sieving such as in a jetmill classifier. It is essential according to the invention that the mixing takes place without milling i.e. there should be no change in grain size or grain size distribution as a result of the
 10 mixing.

In a preferred embodiment the hard constituents, at least those with narrow grain size distribution, are after careful deagglomeration coated with binder metal using methods disclosed in US 5,505,902 or US 5,529,804.
 15 In such case the cemented carbide powder according to the invention consists preferably of Co-coated WC + Co-binder, with or without additions of the cubic carbides, TiC, TaC, NbC, (Ti,W)C, (Ta,Nb)C, (Ti,Ta,Nb)C, (W,Ta,Nb)C, (W,Ti,Ta,Nb)C or Cr_3C_2 and/or VC coated or
 20 uncoated, preferably uncoated, possibly with further additions of Co-powder in order to obtain the desired final composition.

Example 1

25 A. Cemented carbide tool inserts of the type SEMN 1204 AZ, an insert for milling, with the composition 9.1 wt% Co, 1.23 wt% TaC and 0.30 wt% NbC and rest WC with a grain size of $1.6 \mu\text{m}$ were produced according to the invention. Cobalt coated WC, WC-2 wt% Co, prepared
 30 according to US 5,505,902 was carefully deagglomerated in a laboratory jetmill equipment, mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C and TaC powders to obtain the desired material composition. The mixing was carried out in an ethanol and water
 35 solution (0.25 l fluid per kg cemented carbide powder)

for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with carbon black to a binder phase highly alloyed with W corresponding to a CW-ratio of 0.89. After spray drying, the inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained, Fig. 1.

Before coating a negative chamfer with an angle of 20° was ground around the whole insert.

The inserts were coated with a 0.5 µm equiaxed TiCN-layer (with a high nitrogen content corresponding to an estimated C/N-ratio of 0.05) followed by a 4 µm thick TiCN-layer with columnar grains by using MTCVD-technique (temperature 885-850 °C and CH₃CN as the carbon and nitrogen source). In subsequent steps during the same coating cycle, a 1.0 µm thick layer of Al₂O₃ was deposited using a temperature 970 °C and a concentration of H₂S dopant of 0.4 % as disclosed in EP-A-523 021. A thin (0.3 µm) layer of TiN was deposited on top according to known CVD-technique. XRD-measurement showed that the Al₂O₃-layer consisted of 100 % κ -phase.

The coated inserts were brushed by a nylon straw brush containing SiC grains. Examination of the brushed inserts in a light microscope showed that the thin TiN-layer had been brushed away only along the cutting edge leaving there a smooth Al₂O₃-layer surface.

Coating thickness measurements on cross sectioned brushed samples showed no reduction of the coating along the edge line except for the outer TiN-layer that was removed.

B. Cemented carbide tool inserts of the type SEMN 1204 AZ with the same chemical composition, average grain size of WC, CW-ratio, chamfering and CVD-coating respectively but produced from powder manufactured with

conventional ball milling techniques, Fig. 2, were used as reference.

Inserts from A were compared to inserts from B in a wet milling test in a medium alloyed steel (HB=210) with hot rolled and rusty surfaces. Two parallel bars each of a thickness of 33 mm were centrally positioned relative to the cutter body (diameter 100 mm) and with an air gap of 10 mm between them.

The cutting data were:

Speed= 160 m/min

Feed= 0.20 mm/rev

Cutting depth= 2 mm, single tooth milling with coolant.

Evaluated life length of variant A according to the invention was 3600 mm and for the standard variant B only 2400 mm. Since the CW-ratio, the negative chamfer and the coatings were equal for variants A and B, the differences in cutting performance depend on the improved properties obtained by the invention.

20

Example 2

A. Cemented carbide tool inserts of the type SEMN 1204 AZ according to the invention identical to the test specimen (A) in Example 1.

25 B. Cemented carbide tool inserts of the type SEMN 1204 AZ identical to the reference specimen (B) in Example 1.

C. A strongly competitive cemented carbide grade of the type SEKN 1204 from an external leading carbide producer with the composition 7.5 wt-% Co, 0.4 wt-% TaC, 0.1 wt% NbC, 0.3 wt% TiC rest WC and a CW-ratio of 0.95. The insert was provided with a coating consisting of a 0.5 μm equiaxed TiCN-layer, 2.1 μm columnar TiCN-layer, 2.2 μm $\text{K-Al}_2\text{O}_3$ -layer and a 0.3 μm TiN-layer.

30

Inserts from A were compared against inserts from B and C in a dry milling test in a low alloyed steel (HB=300) with premachined surfaces. A bar with a thickness of 180 mm was centrally positioned relative to the cutter body (diameter 250 mm)

The cutting data were:

Speed= 150 m/min,

Feed= 0.23 mm/rev

Cutting depth= 2 mm, single tooth milling dry conditions.

Insert B broke after 6000 mm after comb crack formation and chipping and insert C broke after 4800 mm by a similar wear pattern. Finally, insert A according to the invention, broke after 8000 mm.

15

Example 3

A. Cemented carbide tool inserts of the type CNMG 120408-QM, an insert for turning, with the composition 8.0 wt% Co, and rest WC with a grain size of 3.0 μm were produced according to the invention. Cobalt coated WC, WC-8 wt% Co, prepared according to US 5,505,902 was carefully deagglomerated in a laboratory jetmill equipment. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with carbon black to a binder phase alloyed with W corresponding to a CW-ratio of 0.93. After spray drying, the inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained.

The inserts were coated with conventional CVD TiN+TiCN, 1+1 μm .

B. Cemented carbide tool inserts of the type CNMG 120408-QM with the same chemical composition, average grain size of WC, CW-ratio and the same CVD-coating respectively but produced from powder manufactured with conventional ball milling techniques were used as reference.

Inserts from A and B were compared in a face turning test where the resistance against plastic deformation was measured as the flank wear. The work piece material was a rather highly alloyed steel, a bar with diameter 180 mm (HB=310). The cutting data were:

Speed= 290 m/min

Feed= 0.30 mm/rev

Depth of cut= 2 mm

The flank wear after two passages (average for three edges per variant) was found to be 0.27 mm for variant A according to the invention and 0.30 for variant B.

Example 4

A. Cemented carbide inserts of the type CNMG120408-MM, an insert for turning, with the composition 10.5 wt-% Co, 1.16 wt-% Ta, 0.28 wt-% Nb and rest WC with a grain size of 1.6 μm were produced according to the invention. Cobalt coated WC, WC-6 wt% Co, prepared according to US 5,505,902 was carefully deagglomerated in a laboratory jetmill equipment, mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C and TaC powders to obtain desired material composition. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with carbon black to a binder phase highly alloyed with W corresponding to a CW-ratio of 0.87. After spray drying, the

inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained.

The inserts were coated with an innermost 0.5 μm equiaxed TiCN-layer with a high nitrogen content, corresponding to an estimated C/N ratio of 0.05, followed by a 4.2 μm thick layer of columnar TiCN deposited using MT-CVD technique. In subsequent steps during the same coating process a 1.0 μm layer of Al_2O_3 consisting of pure κ -phase according to procedure disclosed in EP-A-523 021. A thin, 0.5 μm , TiN layer was deposited, during the same cycle, on top of the Al_2O_3 -layer.

The coated insert was brushed by a SiC containing nylon straw brush after coating, removing the outer TiN layer on the edge.

B. Cemented carbide tool inserts of the type CNMG120408-MM with the same chemical composition, average grain size of WC, CW-ratio and the same CVD-coating respectively but produced from powder manufactured with conventional ball milling techniques were used as reference.

Inserts from A and B were compared in facing of a bar, diameter 180, with two, opposite, flat sides (thickness 120 mm) in 4LR60 material (a stainless steel).

The cutting data were:

Feed= 0.25 mm/rev,

Speed= 180 m/min and

Depth of cut= 2.0 mm.

The wear mechanism in this test was chipping of the edge.

Result

Insert	Number of cuts
A, according to the invention	19
B	15

Example 5

- A. Cemented carbide turning tool inserts of the type
- 5 CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC with a grain size of 1.6 μm were produced according to the invention. Cobalt coated WC, WC-5 wt% Co, prepared according to US 5,505,902 was carefully deagglomerated
- 10 in a laboratory jetmill equipment, mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C, TaC and (Ti,W)C powders to obtain desired material composition. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide
- 15 powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with tungsten powder to a binder phase alloyed with W corresponding to a CW-ratio of 0.95. After spray drying,
- 20 the inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained.

- The inserts were coated with an innermost 5 μm layer of TiCN, followed by in subsequent steps during the same
- 25 coating process a 6 μm layer of Al_2O_3 .

- B. Cemented carbide turning tool inserts of the type CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC with a grain size of 1.6 μm were produced according to the
- 30 invention. Uncoated deagglomerated WC was mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C, TaC and (Ti,W)C powders to obtain a desired

material composition. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, 5 was added to the slurry. The carbon content was adjusted with tungsten powder to a binder phase alloyed with W corresponding to a CW-ratio of 0.95. After spray drying, the inserts were pressed and sintered according to standard practise and dense structures with no porosity 10 were obtained.

The inserts were coated with an innermost 5 μm layer of TiCN, followed by in subsequent steps during the same coating process a 6 μm layer of Al_2O_3 .

C. Cemented carbide turning tool inserts of the type 15 CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC produced from powder manufactured with conventional ball milling techniques with the same CW-ratio and almost the same average WC-grain size as insert A and B were coated with 20 the same coating as insert A and B.

Inserts from A, B and C were compared in an external longitudinal turning test with cutting speed 220 m/min and 190 m/min resp., a depth of cut of 2 mm, and a feed per tooth equal to 0.7 mm/revolution. The work piece 25 material was SS 2541 with a hardness of 300 HB and a diameter of 160 mm. The wear criteria in this test was the measure of the edge depression in μm , which reflects the inverse resistance against plastic deformation. A lower value of the edge depression indicates higher re- 30 sistance against plastic deformation.

The following results were obtained:

	v= 190 m/min	v= 220 m/min
	edge depression, μm	edge depression, μm
A	59	85
5 B	56	93
C	89	116

Since the general toughness behaviour was similar it is clear that both insert A produced from Co-coated WC and insert B produced from uncoated WC both according to the invention, performed better than insert C produced with conventional techniques.

Example 6

A. Cemented carbide turning tool inserts of the type CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC with a grain size of 1.6 μm were produced according to the invention. Cobalt coated WC, WC-5 wt% Co, prepared according to US 5,505,902 was carefully deagglomerated in a laboratory jetmill equipment, mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C, TaC and (Ti,W)C powders to obtain desired material composition. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with tungsten powder to a binder phase alloyed with W corresponding to a CW-ratio of 0.95. After spray drying, the inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained.

The inserts were coated with an innermost 5 μm layer of TiCN, followed by in subsequent steps during the same coating process a 6 μm layer of Al_2O_3 .

B. Cemented carbide turning tool inserts of the type CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC with a grain size of 1.6 μm were produced according to the invention. Uncoated deagglomerated WC was mixed with additional amounts of Co and deagglomerated uncoated (Ta,Nb)C, TaC and (Ti,W)C powders to obtain desired material composition. The mixing was carried out in an ethanol and water solution (0.25 l fluid per kg cemented carbide powder) for 2 hours in a laboratory mixer and the batch size was 10 kg. Furthermore, 2 wt% lubricant, was added to the slurry. The carbon content was adjusted with tungsten powder to a binder phase alloyed with W corresponding to a CW-ratio of 0.95. After spray drying, the inserts were pressed and sintered according to standard practise and dense structures with no porosity were obtained.

The inserts were coated with an innermost 5 μm layer of TiCN, followed by in subsequent steps during the same coating process a 6 μm layer of Al_2O_3 .

C. Cemented carbide turning tool inserts of the type CNMG120408-PM with the composition 5.48 wt-% Co, 3.30 wt-% Ta, 2.06 wt-% Nb, 2.04 wt% Ti and rest WC produced from powder manufactured with conventional ball milling techniques with the same CW-ratio and almost the same average WC-grain size as insert A and B were coated with the same coating as insert A and B.

Inserts from A, B and C were compared in a external longitudinal turning test with cutting data 240 m/min, a dept of cut of 2 mm, and a feed per tooth equal to 0.7 mm/revolution. The work piece material was SS 2541 with an hardness of 300 HB and a diameter of 160 mm. The wear criteria in this test was the measure of the maximum flank wear after 5 min in cutting time, which reflects the resistance against plastic deformation.

max. flank wear, μm

B 35

5 C 38

Since the general toughness behaviour was similar it is clear that both insert A produced from Co-coated WC, and insert B produced from uncoated WC both according to the invention, performed better than insert C produced with conventional techniques.

Claims

1. A cemented carbide insert provided with a thin wear resistant coating with excellent properties for machining of steels and stainless steels consisting of WC, 5 - 12.5 wt-% Co and 0 - 10 wt-% cubic carbides such as TiC, TaC, NbC or mixtures thereof in which the WC-grains have an average grain size in the range 1.0 - 3.0 μm characterised in that the WC grains have a narrow grain size distribution in the range 0.5 - 4.5 μm and the W-content in the binder phase expressed as the "CW-ratio" defined as

$$\text{CW-ratio} = M_S / \text{wt\%Co} * 0.0161$$

where M_S is the measured saturation magnetization of the sintered cemented carbide insert in kA/m and wt% Co is the weight percentage of Co in the cemented carbide is 0.86 - 0.96.

2. A cemented carbide insert according to the preceding claim characterised in that said coating comprises $\text{TiC}_x\text{N}_y\text{O}_z$ with columnar grains followed by a layer of $\alpha\text{-Al}_2\text{O}_3$, $\text{k-Al}_2\text{O}_3$ or a mixture of α - and $\text{k-Al}_2\text{O}_3$.

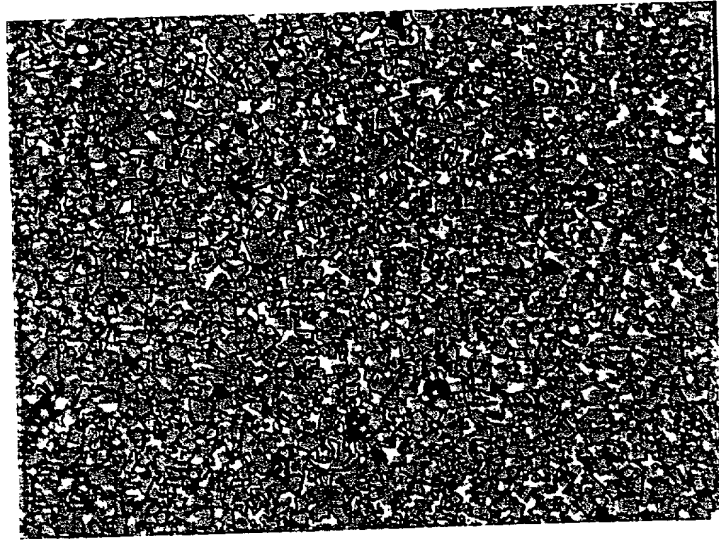
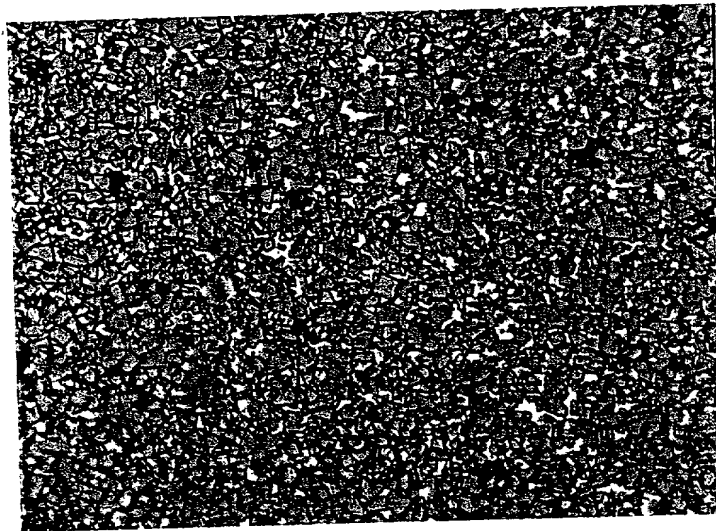
Abstract

The present invention relates to a cemented carbide insert with excellent properties for machining of steels and stainless steels. The cemented carbide comprises WC and 4 - 25 wt-% Co. The WC-grains have an average grain size in the range 0.2 - 3.5 μm and a narrow grain size distribution in the range 0 - 4.5 μm .

According to the method of the invention a cemented carbide cutting tool insert is made by mixing powders of WC, TiC, TaC and/or NbC, binder metal and pressing agent, drying preferably by spray drying, pressing to inserts and sintering. The method is characterised in

- that a deagglomerated WC-powder with a narrow grain size distribution is used,
- that the powders of TiC, TaC and/or NbC are deagglomerated and
- that the mixing is wet mixing with no change in grain size or grain size distribution.

1/1

**Fig. 1****Fig. 2**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

CEMENTED CARBIDE INSERT FOR TURNING, MILLING AND DRILLING

the specification of which (check only one item below):

☐ is attached hereto.

☒ was filed as United States application

Number _____

on January 15, 1999

and was amended

on _____ (if applicable).

☐ was filed as PCT international application

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on _____

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I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

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PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. § 119
Sweden	9602811-3	19 July 1996	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
PCT	PCT/SE97/01243	8 July 1997	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
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(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (CONTINUED)
(Includes Reference to Provisional and PCT International Applications)

ATTORNEY'S DOCKET NO.

024444-580

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U.S. APPLICATIONS		STATUS (check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT APPLICATION NO.	PCT FILING DATE	U.S. APPLICATION NUMBERS ASSIGNED (if any)		

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (CONTINUED) (Includes Reference to Provisional and PCT International Applications)		ATTORNEY'S DOCKET NO.
		024444-580
1-01 FULL NAME OF SOLE OR FIRST INVENTOR Mats WALDENSTRÖM		SIGNATURE <i>Mats Waldenström</i> DATE Feb. 4 1999
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RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		
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RESIDENCE		CITIZENSHIP
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FULL NAME OF SEVENTH JOINT INVENTOR, IF ANY		SIGNATURE DATE
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FULL NAME OF EIGHTH JOINT INVENTOR, IF ANY		SIGNATURE DATE
RESIDENCE		CITIZENSHIP
POST OFFICE ADDRESS		
FULL NAME OF NINTH JOINT INVENTOR, IF ANY		SIGNATURE DATE
RESIDENCE		CITIZENSHIP
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